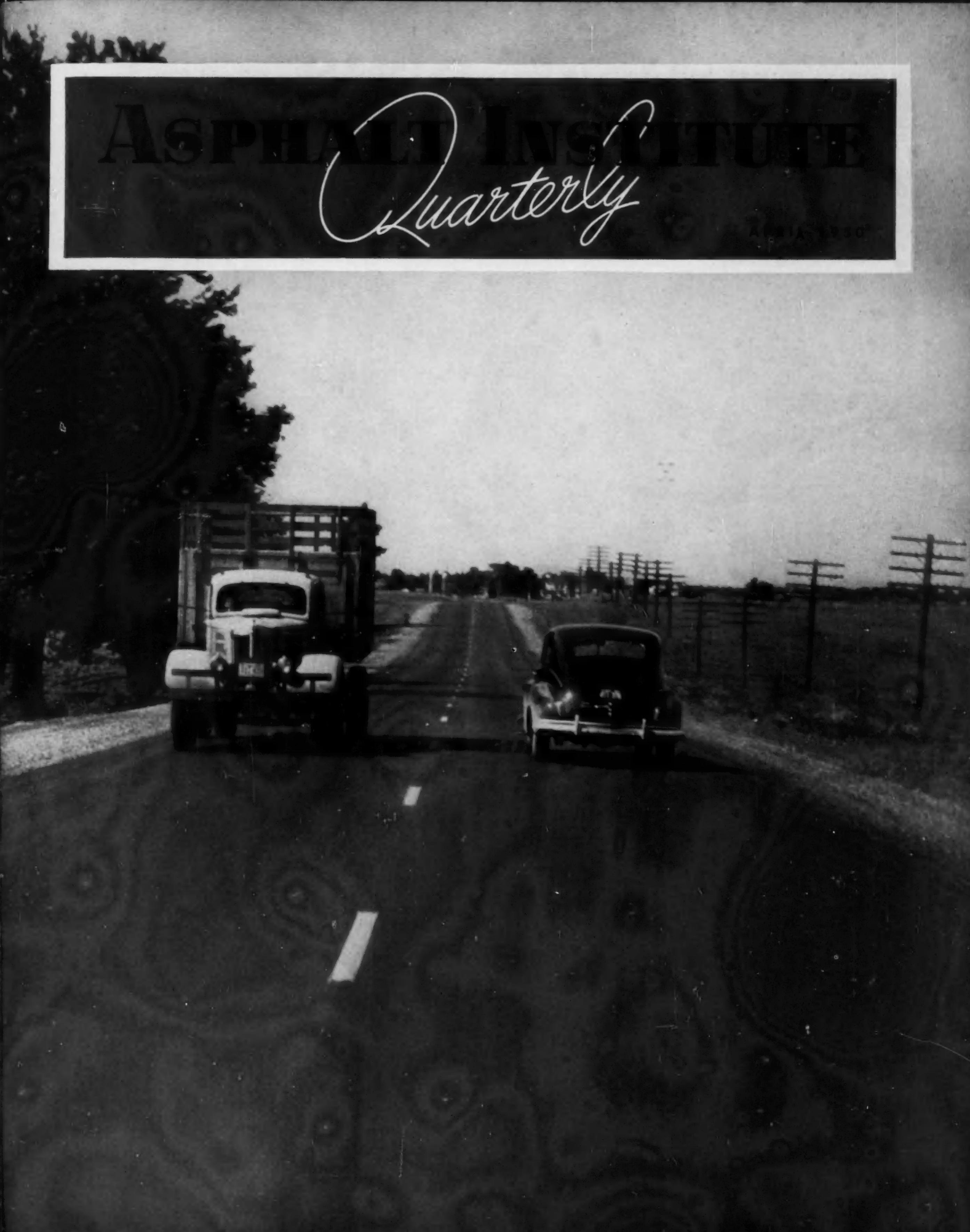
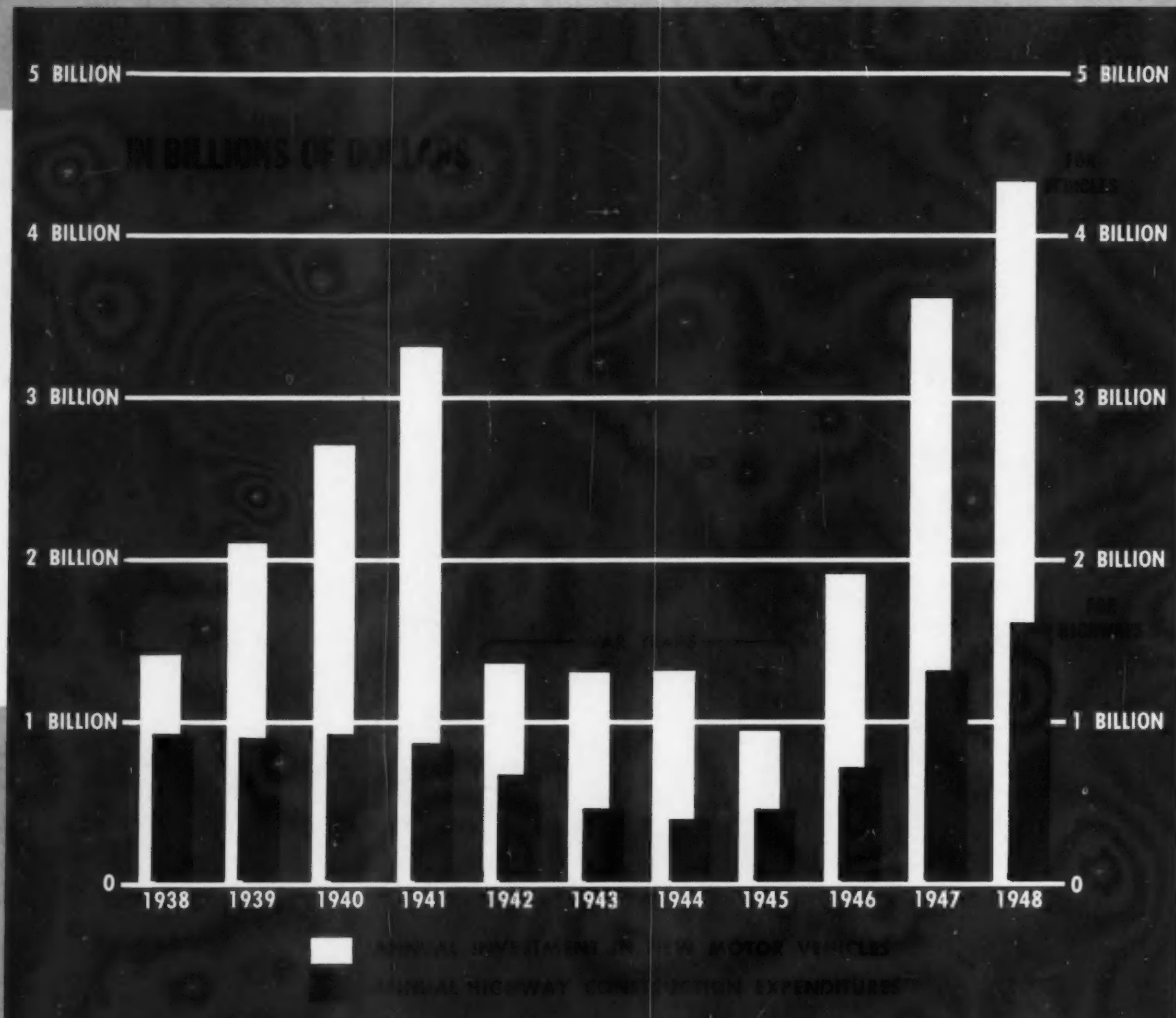
ASPHALT INSTITUTE *Quarterly*

APRIL 1950



ANNUAL INVESTMENT IN NEW MOTOR VEHICLES
VERSUS
ANNUAL HIGHWAY CONSTRUCTION EXPENDITURES



This Chart shows in graphic form how a *relatively decreasing* annual "Highway Construction Expenditure" is sustaining record-high "Investment in New Motor Vehicles." In 1938 the *ratio* was sixty-four percent; in 1948 it had decreased to thirty-seven percent.

In general, it is sound economy for the highway to provide the foundation for the entire vast automotive industry at a decreasing ratio of expense. The Railroad Systems have found that it is now primarily for rolling stock, not for roadbed, that *their* capital expenditures must be made.

This does not mean that highway construction expenditures should be small, but rather that they should be wise. Savings, potentially amounting to billions of dollars, are at stake.

Highways as they become inadequate in any way may be scrapped, but better, they may be salvaged. *Widening and resurfacing* operations are already saving and improving thousands of miles annually. The cost per mile is but one-third to one-half of new construction expenditures. This issue of the Quarterly enlarges upon that aspect of highway improvement.

Charted by The Asphalt Institute, April 1950

Quarterly

VOL. 2 No. 2 APRIL 1950

The Asphalt Institute Quarterly is published by the Asphalt Institute, a national, non-profit organization sponsored by members of the industry for the purpose of promoting interest in the use of asphaltic products.

The names of the Member Companies of the Institute, who have made possible the publication of this magazine, are listed herein on page 15.

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Articles may be freely reprinted with credit line. Correspondence should be addressed to the Asphalt Institute Quarterly, 801 Second Avenue, New York 17, N. Y.

COVER

Featured on the double cover is a view of U. S. Route 169 between Hibbing and Virginia in Minnesota. Formerly a narrow, rigid-type pavement, a four foot widening, a flexible-type granular base, and an over-all three inch resurfacing with *asphaltic* concrete have made it entirely adequate. This pavement is located in the Iron Range, where it is subjected to exceptionally heavy truck hauling.

This graphic chart features an important changing relation between the vast *annual capital expenditures* for motor vehicles and for roads. It does not include maintenance charges, nor the tremendous costs of vehicles and roads previously existing.

EDITORIAL

The American public is being called upon to carry a burden of taxation unequalled in all our history, not only in total dollars, but in percentage of national income. New demands are made daily and, while many of them appear meritorious, it must be evident to all that in the near future curtailment somewhere will become a necessity. Where will it take place and will the procedure be orderly, or sudden and drastic?

Highways are one facility supported by taxation. They are vital to our present existence, but how much do they require for improvement, and are there alternate procedures from which one can be chosen which will show marked economy as compared with others? These questions must be answered.

Estimates of highway needs vary widely. One recently made is predicated upon a so-called study of pavement life, in which it is concluded that this ranges from seven to twenty-eight years. When carefully analyzed by the skilled highway engineer, with due allowance for averages, appropriate conclusions may be drawn, but for the general public it is quite misleading, and misuse of this report already has been a positive dis-service to correct understanding. The impression is given that the entire road system must be renewed, whereas in most instances betterment of existing facilities, plus normal maintenance, will provide needed improvements with only small mileage requiring complete replacement.

The problem then, is *to determine the degree* in which each highway is inadequate and then to improve those portions that are deficient. A recent twenty-five mile project illustrates this wide variation in estimates. The first report called for an entirely new location because there were many steep hills and dangerous curves. More careful study, however, indicated that these hills and curves were concentrated in four rather limited areas. After a re-survey it was found possible to retain eighteen miles of the old road with only seven miles of re-location, thus saving several million dollars over the first plan, yet without sacrifice of any real needs.

The present system is the product of much work and planning, yet it has been built in a rather short time. In 1925, there were 20,000,000 motor vehicles in the United States and about 70,000 miles of paved roads on the State and other rural systems. In 1950, there are approximately 45,000,000 motor vehicles and the 70,000 paved miles has grown to 450,000. A new highway system has been created. Moreover, during this twenty-five year period there were developed the road-building tools, which today have such great efficiency compared with hand-labor methods of a quarter of a century ago, and which will make future rehabilitation so much quicker and easier.

This improvement can be accomplished in a large measure through skillful use of *maintenance*. New construction costs, though they must be large, are already *relatively* decreasing, as shown on the chart on opposite page. It is the fashion at the moment, however, to complain that so much money is expended for maintenance. What of it? Eventually, as any system reaches full development, all new money will be expended for maintenance.

This issue of Quarterly is devoted to a description of some of the ways and means by which a number of states are making their highway dollars go further, thus holding taxation to a minimum, yet providing a better and safer system with each passing year.

HIGHWAYS— TODAY and TOMORROW

Resurfacing is a general policy in New York State.

Traffic uses *asphaltic* concrete, as soon as cooled. (Province of Quebec)

Highways are a utility, and like every other utility should be fashioned to serve the purpose and no more. Arguments are advanced sometimes to prove that large new expenditures are justified, because of savings to be secured through more efficient motor vehicle operation. To a certain degree this is true, but the major part of such potential saving is obtained *when an all-weather surface is secured,* free from dust and mud. This often may be accomplished by a simple surface treatment and, until traffic reaches a volume where increased maintenance will permit capitalization of a heavier pavement, there is no dollars-and-cents gain by making a change. It thus is a waste of funds to overbuild any highway, and funds can be wasted on a main route just as easily as on a back country road.

TODAY'S CONGESTION

Probably the greatest single cause of congestion today is the out-of-balance size relationship between the highways and the vehicles which traverse them. During the war, highways were generally neglected, receiving but the barest minimum of maintenance and few betterments. Motor vehicle design, however, was developed greatly during the same period, with production now not only in larger numbers than ever before, but the cars and trucks themselves are wider and longer.

The present highways were built originally for smaller vehicles, also travelling at lower speeds. Now, partly because of wartime delay, nearly one-half of all state roads are still only 18 feet (or less) while but a very small percent are over 20 feet wide. Under these conditions, the modern car simply does not have enough room in which to maneuver, either laterally or longitudinally. How much more, then, is required? It is a matter of record that when existing roads are widened to from 22 to 24 feet and resurfaced, they can carry comfortably and safely several hundred vehicles per hour, and it is illuminating to note what a small percentage of all highways (even state highways) carry as many as even several hundred vehicles per day. Inasmuch as

widening can be accomplished for but a small fraction of the amount required to build an entirely new pavement, it is apparent that such procedure should be followed on a much greater scale than presently is the case.

PRACTICAL MODERNIZATION

Perhaps it is this modernization operation that is *intended* when statements are made to the effect that the existing roads are obsolete and that in another ten years all of them will require replacement, because, except for a very limited mileage adjacent to cities and in certain of the great industrial centers, complete replacement is neither required nor is it desirable. There are thousands of miles of present roads which are capable of taking traffic indefinitely, with minimum maintenance, that actually are already composite structures, embodying in their lower courses, gravel, macadam, brick and block, which were first placed 20, 30, and even 50 years ago. These foundations are beyond price. Not only do they represent an investment of billions of dollars, but into their building went the age-old accumulated deposits of easily available aggregates now so largely exhausted.

Of course all the deficiencies in these older roads may not be corrected one hundred percent simply by widening to 24 feet. There is the matter of sight distance on even such a pavement when traversing rolling or mountainous country. The need, however, can be met by building a third lane on the upgrades so that slow moving vehicles can move over. This is a special kind of widening and, with appropriate lane marking, will provide safe and efficient highway operation. Where traffic volume is heavy, widening to four lanes, over the hills where sight distance is deficient, will be the solution.

Then there is often the possibility of making the present road a one-way road for a mile or so and building a new road roughly parallel thereto for traffic in the opposite direction. Such improvement is effective, particularly at river crossings where the existing bridge is strong enough but not sufficiently wide for safe two-way traffic. Such skillful engineering utilizes existing facilities to the maximum possible extent, holding new construction to a minimum, with no traffic delays while the improvement is underway, yet obtaining as a final result all the benefits that possibly could be derived from an entirely new dual highway to be built at two or three times the cost.

By several procedures of introducing extra width or short sections of new highways at intervals, on even the most heavily travel'ed routes, it would be possible to eliminate rather soon the long processions of cars and trucks now so frequently encountered. Further, this widening procedure accomplishes something else, that is reduction of harmful effect from heavy loading. The improvement in pavement behavior where repetition of load is spread over the wider area of a 24-foot width as compared to the strip less than 2 feet wide on an 18-foot pavement, is most marked, and far more efficient than gained through increasing pavement thickness alone. By such a plan, thousands of miles can be brought up-to-date as compared to only a few hundred if complete replacement is the rule. Perhaps, also, in this atomic age, it may be just as well to have a lot of roads over which traffic may be widely dispersed, rather than placing so much concentration on a few super highways that are vulnerable indeed.

IMPROVED EQUIPMENT

Emphasizing the merit of a betterment program as contrasted with entire replacement raises a fair question; if this is so simple, why hasn't it been done before on a large scale — and the right answer perhaps is that only in recent years has equipment become available which will do the job so quickly and at such low cost. Removal of the old earth shoulder was formerly accomplished by hand-labor, or at best was a rather crude blade-grader operation, the subgrade being so disturbed that the widened pavement often settled. Moreover, traffic was stopped for long intervals while hand work was underway.

Today, there are mechanical trenching tools which excavate neatly to the exact width desired, and pile the dirt so removed on the side away from traffic. Then there are hopper attachments for trucks, so that the material for widening the base, whether stone, gravel, or asphalt mixtures, may be placed in the trench exactly in the amount and thickness required. Special built rollers, made to operate in narrow places, are available which produce the same compaction as that obtained under standard type rollers. Thus it is possible to widen one side of the road at a time, with minimum interference to traffic. Similarly in the resurfacing, one-half the roadway is done at a time, and the new asphalt pavement can be travelled over as soon as it has cooled, which is but a matter of *minutes*. Thus the ingenuity of the manufacturer and the engineer are providing the needed tools to produce the highways of tomorrow, by taking full advantage of the investment of the past.

HIGHWAY SALVAGE IN DELAWARE

This is an authorized condensed version of the paper, entitled: "Economic Rehabilitation of Existing Highways," in which at the Meeting of the Assoc. of Highway Officials of the North Atlantic States, in New York City, February 23, M. Allan Wilson, Chief Engineer, Delaware State Highway Department, ably presented the construction methods and economic philosophy adopted by that state in coping with the heavy traffic of the industrial East.

On Delaware's 3900-mile highway system, primary and secondary roads account for about forty per cent of the mileage and local roads the remaining sixty. Of the improved forty per cent, however, only about one-third are of adequate width and surface type. To prevent obsolescence a very large amount of reconstruction is needed and, with funds limited, the widening and resurfacing of the existing highways is an economically sound procedure.

It seems logical to question if our highway system will reach the point where we can say it is adequate for the traffic at all times, since we are limited in funds and also the facilities required to carry out reconstruction that will keep our highways 100% adequate. Thus, the economic rehabilitation of our existing highways by widening and resurfacing appears to be one method whereby we can continue the satisfactory use of our highway transportation system.

WHEN TO RESURFACE

Probably the most important factor to consider in the salvaging of any pavement is when to resurface. If resurfacing is delayed beyond a certain point the cost rises rapidly. One thing is certain, a pavement should not be allowed to deteriorate to such an extent that it loses its value as a base for any subsequent resurfacing. Of course, the maintenance costs are an important factor and a rapid rise in the maintenance costs of any section of highway is a certain indication that something needs to be done. No absolute rule has been followed or established in Delaware. Each case has been judged on its own merits after the Division and Staff engineers have made their inspection.

To date our method of deciding where and when to resurface, based on engineering judgment, has been successful because we have tried to keep before us the words of A. M. Wellington, one of the outstanding engineers of the nineteenth century who wrote in his monumental work, The Economic Theory of Railway Engineering, "The Engineer's true function and excuse for being, as an engineer as distinguished from a skilled workman, begins and ends in comprehending and striking a just balance between topographical possibilities, first cost, and future revenue and operating expenses."

Several states in the country, Arizona, Colorado, and Connecticut to name a few, have set up a so called "Sufficiency Rating Index" for the highways in their respective states. Following ideas and suggestions which were developed and carried out by these states, and following additional procedures set up by the Bureau of Public Roads in a pilot study of a similar nature in Delaware, the State Highway Department is now proceeding with a study of our highways in order to obtain the information which is so urgently needed.

The objective of this study is to provide a numerical rating for each section of the roadway, on the basis of a total of 100 points, allocating 40 for Condition, 30 for Safety and 30 for Service. Each element is further divided into sub-elements for more detailed evaluation. For example, Condition consists of an evaluation of the type, depending on the traffic volume carried by the road, thickness, surface condition, drainage, remaining life, and maintenance economy. The Safety element is divided into subheadings of shoulder and surface widths, stopping sight distances and alignment. Service is broken down to show horizontal curvature, passing opportunity, surface width and riding qualities.

SELECTION OF TYPE

Delaware has engaged in a rather extensive program of widening, and then resurfacing with bituminous concrete, since 1937 and especially since the war years. This type of construction has many advantages which have been partially responsible for its increased use and adoption. The major advantages may be enumerated as follows: (1) It is not necessary to inconvenience the traveling public by closing the road to traffic; (2) the new width of pavement is ready for almost immediate use; and (3) it is possible to complete within a short time an extensive mileage of roadway, with improved riding and safety qualities.

The type of bituminous resurfacing plays

U. S. Route 13 in Delaware, near Odessa, as it appeared in 1940. **Same location after widening and resurfacing with *asphaltic* concrete.**

an important part in determining the life expectancy and the economic soundness of a rehabilitation project. Crack surveys, laboratory tests and personal field observations indicate that hot-mix asphaltic concrete is the most satisfactory type of mix. Open graded cold mixes tend to become brittle, ravel slightly, corrugate and permit the entrance of surface water into the old cracked and worn pavement. More than any other single factor, the high permeability of open graded mixes with the consequent damage to the already worn concrete pavement and subgrade has caused us to specify a more and more dense mix.

Design practice in Delaware originally started with resurfacing in two courses making an average thickness of 2 inches. More recently the trend has been toward thicker surfaces. The present practice calls for a thickness of 3" or more, depending on the condition of the old pavement, and on whether or not substantial strengthening of the pavement is needed. In extreme cases 4" of bituminous concrete has been used to compensate for very weak bases. In resurfacing, the bituminous concrete is placed in two or more courses depending on the strength required and the condition of the existing surface. Current practice calls for a binder course of 1¾" thickness with a top or surface course of 1¼" giving a compacted mat of hot mix 3" thick.

CONSTRUCTION PROCEDURE

Regardless of the type of resurfacing material selected, preparation of the road surface to receive resurfacing is a feature too often omitted. Careful preparation of wood surface prior to painting, for example, are all such fundamental steps for successful work that it is curious that need for similar care has been so frequently overlooked. Any fat or bleeding bituminous patch on the old pavement should be removed. All unsealed transverse cracks and minor longitudinal cracks are sealed with 85-100 penetration crack filler. Also, major cracks are filled with a grout mixture.

After priming the old surface with an asphaltic tack coat applied at the rate of approximately 0.1 gallon per square yard, spreading of bituminous concrete material is accomplished with self powered pavers capable of spreading to line and grade without the use of side forms. Ordinarily the resurfacing is performed with traffic maintained. On two lane pavements we require that one way traffic be maintained with the length of such one-way zones being kept to a minimum. Also, it is required that flagmen be used to direct traffic where one-way traffic is necessary. Ordinarily less confusion to traffic results if the paver is operated toward the plant.

Normally the surfacing material is placed in single lane widths with the requirement that the longitudinal joints in the courses be offset approximately 6" from the one below. This requirement is to avoid the possibility of a plane of weakness being formed. The longitudinal joint on the top course is located on the centerline of a two-lane pavement.

Rolling requirements are such that at least two rollers are required at all times. One of these must be an 8 to 10 ton tandem roller while the other a 10 to 12 ton 3 wheel roller. However, the latter may be, and generally is, replaced by a 10 ton tandem upon permission of the Engineer. In addition, another 10-12 tandem roller is specified when the rate of application of material exceeds 40 tons per hour per inch of thickness.

ENGINEERING AND LABORATORY CONTROL

In order to obtain first class jobs, skillful engineering and laboratory control during construction is a necessity. The minimum engineering organization required in Delaware is a project engineer or inspector who supervises the laying of the hot mix and other incidental work on the road; a field inspector who also doubles as a checker and takes tickets from the truck drivers and checks the quantities delivered to the project; a plant inspector and two assistants who control the manufacture of the bituminous concrete.

Our plant inspectors do not just watch weights and check temperatures. They must be capable of running screen analyses and combining bin samples into the most efficient batch weights that will yield the desired product. Neither operation of the plant nor necessary mix changes can be delayed while waiting for a laboratory report. For this purpose each plant is provided with its own small properly equipped laboratory.

SALVAGE IS ESSENTIAL

The cost of hot-mix bituminous concrete varies, as would be expected, with the price of materials and the length of haul. Based on 1948 contract prices a brand new rural road, 24 feet wide properly designed now costs approximately $150,000 per mile to build. However, to *resurface* a worn-out rural road, 24 feet wide with bituminous concrete — the familiar smooth "black-top" — costs less than a third of this amount.

We, in Delaware, believe that the method of resurfacing we have discussed has proved advantageous in preserving and salvaging pavements in various stages of deterioration. The demands for highway improvements in Delaware have reached a point where our finances will not permit reconstruction as rapidly as traffic demands. Consequently, it is necessary for us to consider rehabilitation rather than reconstruction, particularly in view of the fact that rehabilitation can be accomplished at approximately one-half to one-third the cost of reconstruction.

It is our opinion that with the rapid increase in traffic and the demand for more dual and divided highways the only way the State Highway System can be preserved is by economic rehabilitation of our existing highways. Thus, the present answer to our problem seems to lie in the maximum salvage of our present roadways by resurfacing.

An old rigid type pavement, Highway No. 29 in Clark County, Wisconsin.

The same location, showing the 3-inch resurfacing of *asphaltic* concrete, placed in 1949.

Courtesy State Highway Commission of Wisconsin.

SAVING AND IMPROVING MID-WESTERN PAVEMENTS

TYPES OF RESURFACING

Asphalt resurfacing in the Mid-West may be classified under the four general headings of surface treatments, road-mix, hot-mix and composite types. For the last-named, granular lifts are constructed over the old rigid type slab before placing the hot-mix asphaltic resurfacing.

The surface treatment types are constructed as double or triple surface treatments, ranging in thickness from ¾ to 1 inch. They are frequently used where "scaling" or other objectionable blemishes are progressing on the surface of the rigid slab. Where this type of resurfacing is used the old pavement should still be fairly smooth and in good repair.

Road-mix type resurfacing, from 1½ to 2½ inches in thickness, is used where projects are so small that they do not justify the added costs for moving in a hot-mix asphalt plant. It is generally restricted to use where the old rigid slab is in fair condition, with but few maintenance patches.

Hot-mix asphaltic resurfacing, varying in thickness from 2 to 6 inches, is used chiefly where the old rigid slab is in a poor or critical condition, rough or where excessive "pumping" or internal disintegration has occurred. Hot-mix asphalt concrete is used chiefly in this type of construction because of its high resistance to displacement under traffic, but sheet asphalt has been used to some extent where good sand is cheaply available.

The composite type of resurfacing, which requires a granular lift or base, is used where it is desired to correct low grades, where the subgrade has settled badly, where the old slab is in a critical condition, where rocking slabs are encountered, where maintenance patches of questionable stability are so numerous that it would be uneconomical to remove them or where there is some question as to whether the old pavement should be entirely replaced. The thickness most frequently used for a granular lift is 6 inches with 3 inches for the hot-mix asphaltic concrete surface course.

PREPARING BASE

Most asphalt resurfacing being constructed today is the hot-mix asphaltic concrete type, where resurfacing is placed directly upon the old slab. Before placing the resurfacing, however, it is essential that all cavities under the slab (which develop chiefly from "pumping") be corrected by undersealing, and all rocking slabs and maintenance patches of questionable stability be removed and replaced with suitable patching material to at least the full depth of the old slab.

For undersealing, a number of states including Ohio, Texas, Missouri, and Illinois are using an asphalt cement having a high softening point (185°F. or more) and low penetration, both for economy and the excellent results obtained. Asphaltic concrete is being used extensively also as a base patching material, since its cost per unit of volume is about the same as other suitable base materials while, in addition, all excavations may be filled and used during the same day, thus eliminating extra costs for numerous barricades and lights, and with minimum restraint to traffic.

Where old pavements contain wide cracks or joints which have been filled with asphalt such material should be removed and replaced with a fine graded asphaltic mortar mixture. Where patches are in place containing an excess percentage of asphalt they should be removed before resurfacing. If such maintenance mixtures are stable and contain about the optimum percentage of asphalt however, it is not necessary to remove them.

WIDENING EXISTING PAVEMENTS

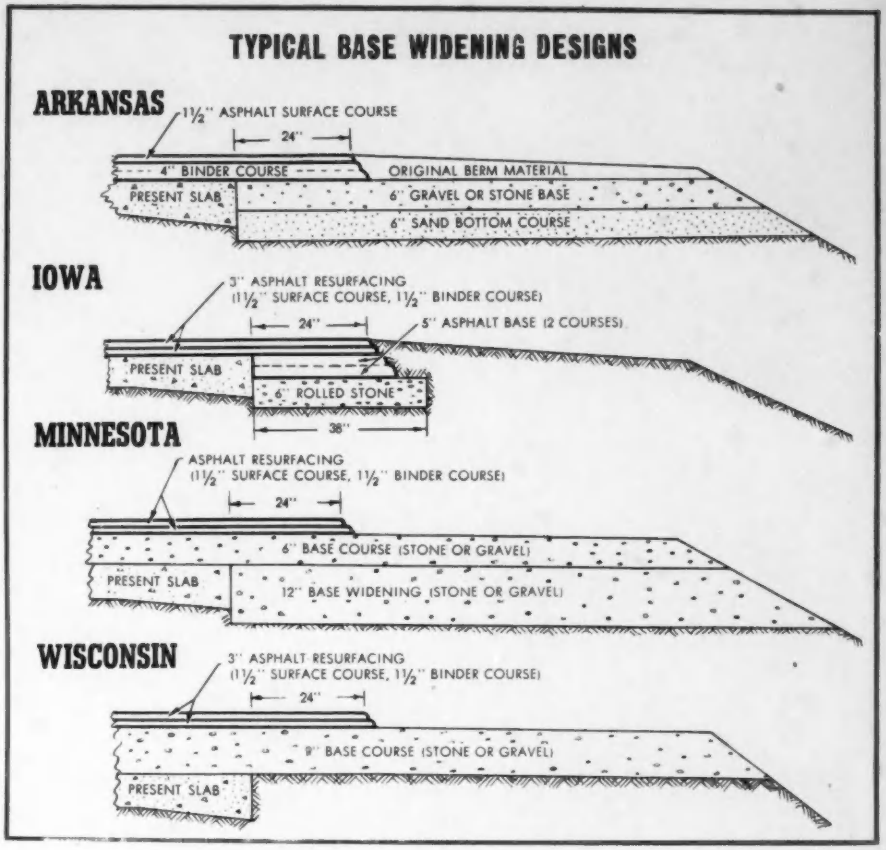
Many of our pavements now in need of reconditioning are also too narrow for modern traffic. Even on the primary State Systems of this area there are many miles of pavement having widths of only 16 to 20

feet. Minimum pavement widths of at least 22 to 24 feet are today required, depending upon the volume of traffic. Consequently in modernizing an old pavement, widening to a satisfactory width before it is resurfaced is also essential.

Ohio was one of the first states to investigate the use of asphaltic concrete for widening old pavements before resurfacing them. There, both for its low cost and resistance to the development of a longitudinal crack in an asphaltic resurfacing adjacent to the junction of the widening and old pavement, *asphaltic concrete base material* has been approved in widening and resurfacing design. Iowa and Missouri now are using similar designs for asphaltic base widening.

Minnesota on much of its resurfacing requires a 6-inch granular lift over the old slab before it is resurfaced with a 3-inch course of asphaltic concrete. Where a pavement is widened the granular base widening extends to the ditch with a total thickness of 18 inches, including the granular lift. Wisconsin frequently uses an 8 or 9-inch granular lift over an old slab and it also extends to the ditch. On the widened pavement section a 3-inch resurfacing extends 2 feet over the widened portion of the granular lift.

As all these variable designs of base widening are giving satisfactory results, it is evident that the type of base widening to use depends upon the *cost* for the various materials. For example, where aggregates are exceptionally cheap, granular base widening constructed in combination with granular lifts should be used in a resurfacing program, while where aggregates are expensive, asphaltic concrete base widening should be the choice.



ECONOMY IN COST AND MAINTENANCE

Prevailing costs for hot-mix asphaltic concrete resurfacing vary considerably and, in states where projects are small, costs generally are higher than where jobs are of sufficient size to reduce the overhead expense average. Current costs, available from seventeen states, located from Coast to Coast and from the Canadian Border to the Gulf, average from \$3.42 to \$7.85 per ton.

In most instances it has been proven that resurfacing an old rigid type pavement is economical and extends its life for many years. For example, on a principal east and west route in one mid-west state, a 5-mile project was resurfaced in 1947 with a 2¾-inch asphaltic concrete surface at a cost of \$20,000 per mile. This cost included a 9-inch crushed stone base widening constructed 3 feet wide on each side of the slab. The annual maintenance costs on this project *before* and *after* resurfacing are shown in striking contrast at right.

On an adjacent section, which has *not* been resurfaced, the maintenance costs (including much patching) during 1948 were \$3,500 per mile and during 1949 were \$7,000 per mile. This route is one of the heavy duty highways of the region, and it is evident that resurfacing over the entire length of this old pavement would be a profitable procedure, as the saving in maintenance alone would more than finance the entire cost of improvement within a very few years.

BEFORE: OLD RIGID TYPE

	per mile
1944 Annual Maintenance Cost........	\$1,066.
1945 Annual Maintenance Cost........	911.
1946 Annual Maintenance Cost........	942.

AFTER: ASPHALTIC CONCRETE

1947 Annual Maintenance Cost........	149.
1948 Annual Maintenance Cost........	32.


Placement asphaltic concrete widened foundation.


Compacting widened base with special trench roller.


Spreading resurfacing course over widened pavement.


Completed resurfacing.

Lakewood-Rosemead Boulevard, view of completed project.

CALIFORNIA TRANSFORMS THIRTY FOOT ROAD FOR SUPER HIGHWAY SERVICE

Fast-growing Los Angeles, with section after section currently passing from suburban to urban, is fortunate in that many of the suburban roads requiring improvement can still be *widened substantially*. A recent example, in which full advantage was taken of this possibility, is the 5.9 miles project, transforming the Lakewood-Rosemead Boulevard from an inadequate thirty feet to a full divided highway width of approximately seventy-five feet.

The widening and resurfacing work on this boulevard, completed in 1949, was carried out on a scale in keeping with the requirements of very heavy traffic. The vehicle count on Sunday, July 17th, 1949 was 30,470; on Monday, the 18th, 20,611, approximately 20% heavy trucks.

IMPROVEMENT DETAILS

The original thirty-foot asphaltic concrete pavement of three ten-foot lanes was improved by widening and then resurfacing into an asphaltic concrete super-highway of four twelve-foot traffic lanes, with a four-foot median strip, and outside paved shoulders of from six to twelve feet.

The widened portions were paved with four inches of a hot asphalt plant-mix on an eight inch rock base and from zero to one foot of imported subgrade material. The asphalt used was 120 to 150 penetration. The old pavement was resurfaced with hot plant-mix, with a variable thickness of two to four inches in accordance with desired crown. A thin asphalt plant-mix paving was placed on the central dividing strip.

QUANTITIES AND UNIT COSTS

The quantities and costs of principal items were as follows:

41,000 cubic yards roadway excavation at..................53¢
23,000 tons imported subbase material at..................80¢
64,000 tons untreated rock base at..........................$1.25
49,000 tons asphalt plant-mix surfacing (hot) at..$4.15

1 Completed rock base ready for surfacing, except for priming.

2 Applying asphalt prime coat in advance of asphalt plant-mix.

3 Placement of hot asphalt plant-mix surfacing.

4 Thin asphalt plant-mix paving on central dividing strip.

Photos: Courtesy "California Highways and Public Works."

A HIGHWAY IMPROVEMENT PROJECT IN TEXAS

Highways in Texas, before World War II, seldom carried vehicles with gross weights exceeding twenty thousand pounds. Heavy war-time truck transportation requiring that the load limit be increased, the maximum gross load without special permit was then set at forty-eight thousand pounds. Soon after this increase, many pavements began to fail badly.

In 1946, the twenty foot rigid type pavement on U. S. 80 east of Marshall, was showing signs of distress and, to eliminate subgrade pumping, this and other sections of this highway in the vicinity of Marshall were under sealed with a high melting point asphalt in the Spring of 1947. Considerable scaling occurred the following winter immediately after a severe frost.

Late in 1949, the increasing traffic of the past few years on the section immediately east of Marshall was approaching four thousand vehicles per day. To afford a better traffic facility and obtain the maximum salvage value from the existing rigid type, it was then decided to strengthen the present pavement and widen out to a finished roadway width of twenty-four feet — all of asphaltic concrete.

CONSTRUCTION PROCEDURE

The widening was performed by placing a 10" thickness hot-mix asphaltic concrete base widening section on one side of the existing pavement, and resurfacing the entire width of old pavement and new base with a 4" hot-mix asphaltic concrete surface. Before excavating for the base widening, the existing iron ore shoulder material was salvaged by state maintenance forces for replacement upon completion of the widening and resurfacing work.

The hot-mix asphaltic concrete used for base widening was composed of a dense graded mixture, of which 97% to 100% passed a 2" round screen. The mixture was placed without forms in courses of equal thickness, with each successive course being "stepped in" the thickness of the course to form a theoretical 1:1 slope. The mixture was spread with an all-purpose trench spreader and compaction was obtained with a trench type roller and a conventional type tandem roller.

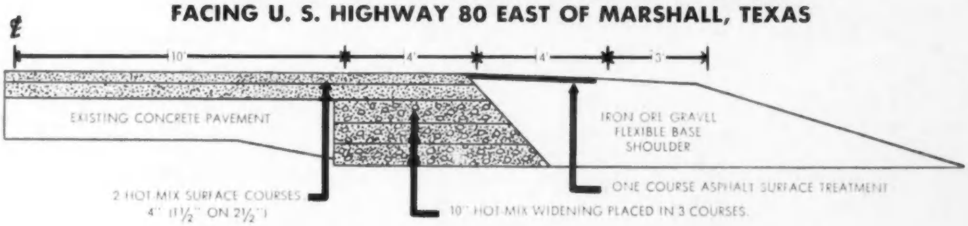
The surface course mixture was composed of a dense graded aggregate of which 97% to 100% passed a ¾" round screen. The asphaltic concrete surfacing material was laid in two courses, the first being 2½" and the second 1½" in thickness. The asphaltic binder used in the base and surface course mixes was 85-100 penetration asphalt cement.

1 Front view of all-purpose spreader placing second course of asphaltic concrete widening.

2 Both tandem and trench type rollers used for compacting asphaltic concrete widening.

3 Close-up view of trench roller compacting asphaltic concrete, immediately adjacent to old rigid pavement.

HOT-MIX ASPHALTIC CONCRETE WIDENING AND RESURFACING U. S. HIGHWAY 80 EAST OF MARSHALL, TEXAS



HALF-SECTION OF ALL WIDENING ON ONE SIDE

— of asphalt plant-mix.

a dividing strip.

Photos: Courtesy "California Highways and Public Works."

Crushed stone being placed on screenings for insulation course.

U. S. 52 near Indianapolis. Formerly a narrow macadam road; in 1925 widened and resurfaced with penetration macadam; in 1941 surfaced with an asphalt hot-mix, intended only as a binder course, but the road is still in excellent condition.

Important Considerations in Widening and Resurfacing Operations

Any existing pavement may be widened and resurfaced. The details of procedure vary somewhat according to the kind of old pavement, particularly whether of the flexible or rigid type. Rigid pavements include not only portland cement, but also various kinds of brick and block pavements which are on a rigid base. Flexible pavements include waterbound and penetration macadam, gravel, slag, and stone foundations, as well as old bituminous surfaces of various kinds. Careful analysis of surface behavior will indicate the improvement required. In many cases, widening, followed by the minimum thickness of new surfacing that will take out irregularities, is sufficient. In others, the roads are too thin for modern traffic yet have considerable supporting power, which only needs augmenting by an additional layer of asphalt surface.

Where a pavement is deficient in supporting power this lack in structural strength is evidenced by a progressive breakdown, resulting in holes and pattern cracking in flexible pavements, or reduction of the slab to small blocks in the case of rigid pavements. In these situations, there are two possible procedures. The first is to place a number of layers of asphaltic concrete to produce a total thickness of new pavement adequate to carry traffic, which is economical up to a maximum of four or five inches depth. Sub-sealing with a high melting point asphalt cement is desirable in such situations prior to resurfacing.

In the second case, where considerable additional strength is required because of the badly broken condition of the old pavement, it usually is more economical to place a composite resurfacing, consisting of a base course of gravel or macadam, followed by a wearing course of asphaltic concrete three inches in thickness. A survey of the primary road system has indicated that in no instance has it been necessary to place such new base courses in depths greater than eight inches, while as a rule, five or six inches is ample.

DETERMINING IMPROVEMENT REQUIRED

The kind of widening required, previous to resurfacing, depends upon the subgrade conditions. Where the subgrade is clay, the widened area should be excavated to a depth slightly below the old pavement, and bleeder drains should be cut through the new shoulder so that drainage from under the old pavement and the widened section will be assured. For clay subgrades, it is usually economical to construct the widened area with granular materials in the bottom and asphaltic concrete or asphalt macadam for the top because of the greater thickness needed. In some instances, fine graded material such as selected soil, iron ore, limerock, caliche, or other local product may be employed.

Placement of an insulation course of fine graded materials, such as stone screenings, directly upon the subgrade, has great value. These are easily spread and permit accurate levelling of the subgrade to correct profile. Moreover, they will absorb excess moisture from the subgrade and can be compacted to a very firm condition, thus providing proper reaction under subsequent rolling. This makes it possible for base, whether of aggregates or asphalt mixtures, to be thoroughly consolidated so that subsequent settlement of the widened area will not take place. Under no circumstances should coarse size aggregate be dumped directly upon the clay subgrade, because the clay will be forced up into the voids and prevent full development of the potential strength of the aggregates placed.

PRE-CONDITIONING OLD SURFACE

Where asphaltic concrete is to be placed directly upon an old pavement, pre-condition of the existing surface is all important.

Compacting stone base with special type roller.

[illegible] of asphaltic concrete surface.

[illegible] edge of asphaltic concrete surface to [illegible] adjacent lane.

Showing asphaltic concrete placed over old and new foundations.

Bituminous patches, either on portland cement or bituminous surfaces, which are over-rich, are almost certain to be reflected through the new surface, and consequently, should be either removed or "burned." In rigid pavements, joint filler should be raked out to a depth of from one to one and one-half inches, thus preventing intrusion into the resurfacing under temperature changes, and excess crack filler spilled on the pavement should be scraped or burned away. Special tools are available for doing this work rapidly and efficiently.

Broken areas in old surface, including cracks and joints, then should be patched, using a fine-graded mix for the purpose. Previously, it was often the custom to use a coarse binder for patching and levelling operations, but experience has demonstrated that a sheet asphalt mix or a fine-graded asphaltic concrete is much better, because of ability to fill shallow depressions and joints in such fashion as to permit feather-edging to more nearly a proper contour. In some instances it is even believed — and there is much data to support the practice — that the fine-graded mix should be placed as the lower (binder) course, and the coarse-graded mix used for the wearing surface. By following such procedure, not only is a very tight bond obtained between the old pavement and the new, so that entry of water between layers is prevented, but a high stability wearing course is accomplished having a coarser surface texture.

Prior to placing this so-called binder course, the surface of the old road should be primed (often called a tack coat), using a rapid setting liquid asphaltic material. A light application only is required, not much exceeding 0.15 gallon per square yard, depending upon the dryness and dust condition of the old surface. Where the old road has a bituminous surface which is fairly rich, the primer may be omitted as the hot-mix resurfacing will bond readily with it. Where the old road is portland cement, brick, or where the old bituminous surface is hard and dry, the treatment is essential.

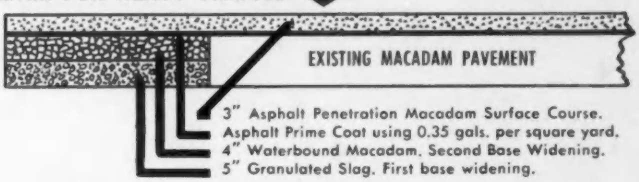
PLACING ASPHALTIC CONCRETE

The asphaltic concrete always should be placed in two or more layers. It is a mistake to attempt to place the entire thickness in one spreading. Even a two-inch surfacing should be spread in two layers. The cost of placement in multiple layers is little, if any, more than placing all at one time, while the advantages of the multi-layer method are many. Even with the placement of a good levelling course, and careful patching, an old pavement is usually irregular, so that it is not possible to take out all of the unevenness in one spreading operation. Moreover, with several layers it is possible to stagger the spreads in such a way that the longitudinal joint does not extend through the resurfacing, hence permitting a better appearance, as well as insuring a completely waterproof condition.

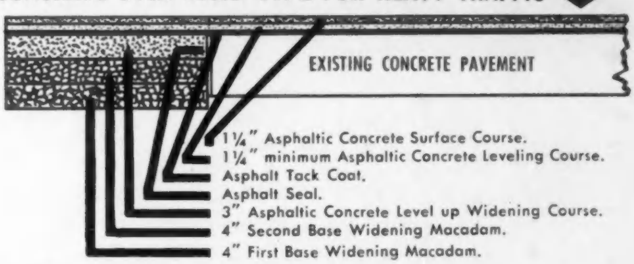
Finally, there is the question of seal coat. Properly designed and constructed hot-mix asphaltic concrete, being dense and waterproof, does not require a seal coat. However, and especially with very coarse graded mixtures, there is occasionally some segregation of aggregate which may produce so-called shadow spots when a pavement is drying off after a rain. These can be eliminated, and a uniform texture appearance secured, by applying approximately four pounds per square yard of precoated sand between the initial and final rolling. The precoated sand should be a lean mix (not over 3% asphalt cement) and should be distributed so as to fill only surface voids, and not make a layer over the entire pavement.

OHIO — TYPICAL CROSS-SECTIONS WIDENING AND RESURFACING

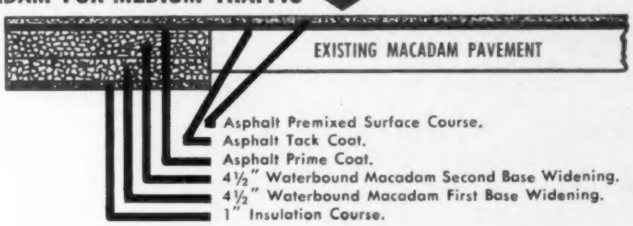
ASPHALT MACADAM FOR HEAVY TRAFFIC



ASPHALTIC CONCRETE OVER RIGID TYPE FOR HEAVY TRAFFIC



ASPHALT MACADAM FOR MEDIUM TRAFFIC



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ALBERT H. HINKLE

With headquarters at 431 Main Street in Cincinnati, Albert H. Hinkle extends the Institute's engineering facilities for the promotion of asphalt throughout the states of Ohio, Indiana, Michigan, Kentucky, and West Virginia.

Now the senior engineer in years of service on the Institute's district engineering staff. Mr. Hinkle's long career, following graduation from Ohio State University in 1907, includes forty-three years of experience in highway engineering work in various states of his present district. In both Ohio and Indiana he organized the Division of Maintenance of the State Highway Departments. In Kentucky, for the Rock Asphalt Institute, he conducted research and served as Consulting Engineer and Director.

A basic contribution to the technique of road maintenance was the pioneer, thoroughly comprehensive Manual, written by Mr. Hinkle and published by the State Highway Department of Ohio in 1919, entitled: "Maintenance and Repair of Highways." In 1924, when the selecting and marking of a national system of highways was just in its formative stage, Mr. Hinkle's State Highway Officials' Conference paper, entitled: "How Shall Interstate Highways Be Named and Marked," proposed many of the suggestions adopted.

Mr. Hinkle is a member of the American Society of Civil Engineers, the Association of Asphalt Paving Technologists, the Society of American Military Engineers, the Ohio Society of Professional Engineers, and the Engineering Society of Cincinnati.

GEORGE H. DENT

From his office in the Mills Building in Washington, George H. Dent directs local Institute engineering activities throughout the states of Pennsylvania, Delaware, Maryland, Virginia, North Carolina and the District of Columbia.

Mr. Dent is second only to Mr. Hinkle in years of service as a District Engineer of the Institute. An alumnus of the University of Maryland, in that state he served with the State Roads Commission successively as Materials Engineer and Bituminous Engineer; and then, just prior to coming with the Institute, as Paving Engineer for the Civil Aeronautics Administration.

An outstanding contribution by Mr. Dent to the highway building industry was Maryland's Mobile Soils Laboratory, devised in 1938. This portable laboratory made possible, ***within an hour,*** completion of tests that would have consumed at least two days if samples had to be submitted to the main laboratory. In practice this has developed a degree of efficiency seldom found in materials testing and been adopted not only in a number of other states but also by the Bureau of Public Roads.

Mr. Dent is a member of the Highway Research Board (Associate), the American Society for Testing Materials, the Association of Asphalt Paving Technologists, the Society of American Military Engineers, the National Society of Professional Engineers, and the Engineer Club of Baltimore.

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The Asphalt Institute Quarterly is presented through the courtesy of the Companies listed herewith, comprising the membership of the Asphalt Institute.

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801 SECOND AVENUE • NEW YORK 17, N. Y.

Printed in U.S.A.

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